See 11
N. 11
of 11
R. 11
of 11
F.

SEVERAL
P. 11
bro. 11 to
por. 11 of
sing. 11 an
Bo. 11 sch. 11
of Pe. 11
nature of the
tory state
mo. 11 ve powe
which they
solid substan
tain. 11 ed amon
the deep.
phytes (P
appear to ex
owever, hav
ocean by the
the waving u
mal. which w
by Ellis (P
sation of the
Comp. iv. 14
in row
al. 11 tuated b
in his R
an beautiful
of a 11 pur
transpare 11
phosphoresce
by the regul
ged arms of th

for the Voy. coll. of *Hydroids* &c.
from the Author.

Notice regarding the Structure and Mode of Generation
of the *Virgularia mirabilis* and *Pennatula phosphorea*. By
ROBERT E. GRANT, M. D. F. R. S. E. F. L. S. Professor
of Zoology in the University of London.

(From the *Edinburgh Journal of Science*, No. 14.)

SEVERAL specimens of the *Virgularia mirabilis*, Lam. and *Pennatula phosphorea*, lately taken in the Frith of Forth, and brought to me alive in sea-water, afforded me a favourable opportunity of observing some of the living phenomena of these singular animals. Notwithstanding the excellent observations of Bohadsch, Ellis, Pallas, and Muller, on the structure and habits of Pennatulæ, there is still much uncertainty respecting the nature of these anomalous zoophytes, and the most contradictory statements are met with in authors respecting their locomotive powers. As they exhibit no point of attachment by which they can adhere, like almost every other zoophyte, to solid substances at the bottom of the sea, no doubt is entertained among naturalists that they float freely to and fro in the deep, and Lamarck has instituted a new order of zoophytes (*Polypi natantes*), for the reception of seven genera which appear to exist in this unconnected state. Many naturalists, however, have even maintained that they swim through the ocean by their own spontaneous movements, effected either by the waving up and down of the lateral expansions of the animal, which was supposed by Pallas (*El. Zooph.* p. 369,) and by Ellis (*Phil. Trans.* liii. 421,) or by the synchronous pulsations of the tentacula of all the polypi; and Cuvier (*An. Comp.* iv. 147.) supposes that the polypi are enabled to keep time, in rowing the mass through the deep, by their being all actuated by one volition. Cuvier expresses the same opinion in his *Règne Animal*, tom. iv. p. 83. A more singular and beautiful spectacle could scarcely be conceived, than that of a deep purple *Pennatula phosphorea*, with all its delicate transparent polypi expanded and emitting their usual brilliant phosphorescent light, sailing through the still and dark abyss by the regular and synchronous pulsations of the minute fringed arms of the whole polypi. But some authors, as Lamarck,

(*An. sans Vert.* ii. 418,) and Schweigger, (*Unter. uber Coral.*) reasoning from what is known regarding other compound animals, have denied the existence of this great locomotive power in a zoophyte placed so low in the scale, as contrary to every analogy, and not necessary to the existence or wants of the animal.

The *Virgularia mirabilis*, (*Pennatula mirabilis*, Mull.) is one of the most beautiful and rare zoophytes found on this coast. The specimens measured from six to ten inches in length, and were dredged up in deep water on the north side of Inch Keith. They perfectly correspond in form and external appearance with the elegant coloured figure given by Muller, (*Zool. Dan.* Tab. xi.) Their *axis* is calcareous, solid, white, brittle, flexible, cylindrical, of equal thickness throughout, and exhibits no mark of attachment at either end. When broken, it exhibits a radiated surface, like the broken spine of an *echinus*. The axis appears to have little connection with the fleshy part, and to consist of concentric layers deposited by the soft parts surrounding it. When a portion of the axis is broken off from either extremity, the animal retracts at that part, so as continually to expose a fresh naked portion of the axis: hence we can take out the axis entirely from its soft sheath, and we always find the lower pinnæ of the animal drawn up closely together, as if by the frequent breaking of the base. These very delicate and brittle animals seem to be confined to a small circumscribed part of the coast which has a considerable depth and a muddy bottom, and the fishermen accustomed to dredge at that place believe, from the cleanness of the *Virgulariæ* when brought to the surface, that they stand erect at the bottom with one end of the axis fixed in the mud or clay. Muller's specimens were likewise found on a part of the Norwegian coast with a muddy bottom. The *polypi*, much resembling those of the common *Lobularia digitata*, are long, cylindrical, transparent, marked with longitudinal white lines, and have eight *tentacula* which present long slender transparent filaments or *ciliæ* on each of the lateral surfaces when fully expanded. The polypi are easily perceived extending through the lateral expansions or *pinnæ*, to near the solid axis, where we observe two transverse rows of small round white *ova* placed under each pinna, and con-

tained within the fleshy substance. These ova appear to pass along the pinnæ, to be discharged through the polypi, as in the Lobularia, Gorgonia, Caryophyllea, Alcyonia, &c. but they are certainly not generated by the polypi themselves, as we might be led to believe by some authors, as Pallas, (*El. Zooph.* 362.) who state as a character of these animals that their polypi are oviparous. The ova in almost every known zoophyte are formed by the common connecting substance of the animal, and not by the polypi, which appear to be only the mouths or organs of digestion. In *Plumulariæ*, *Sertulariæ*, *Campanulariæ*, horny *Cellariæ*, *Antennulariæ*, the ova are formed in vesicles which originate from the centre of the stem. In *Flustræ*, calcareous *Cellariæ*, and some others, the ova are formed in the cells, but exterior to the bodies of the polypi, which disappear before the ova arrive at maturity. In the Lobulariæ, Gorgoniæ, Spongiæ, Clionæ, &c. the ova are formed and matured in the common fleshy substance of the body before they advance to be discharged through the polypi, or the fecal orifices. The formation of the ova by the general connecting mass appeared more obvious in the *Pennatula phosphorea*, where I found innumerable round yellow ova about the size of poppy-seeds placed, not precisely in the situation described by Bohadsch (see *Phil. Tr.* liii. 423.) but at the back part of the pinnæ, and many of them advancing forward in the substance of the pinnæ to pass out through the bodies of the polypi. Both Bohadsch and Pallas have placed the ova in the pinnated part of the stem where I could not detect any, the whole of that part being filled with a very soft semi-muscular substance destined to move the axis, the stem, and the pinnæ.

The axis of the *Pennatula phosphorea*, Linn. (*P. rubra*, Pall.) like that of the Virgularia, dissolves with effervescence in nitric acid. It is so slender and flexible at its extremities, that it is found coiled up at both ends in the contracted state of the animal, and becomes straight in its expanded condition. The polypi resemble those of the Virgularia. They have eight tentacula, with long conical lateral ciliæ. From the dark opaque purple matter, and numerous calcareous spicula covering their sheaths, the polypi cannot so easily be perceived extending along the

pinnæ. On the back part of the pinnated portion of the stem of this animal we observe innumerable *spicula* collected into small groups, and disposed on each side of a mesial longitudinal groove. When viewed through a lens, these slender shining spicula much resemble the groups of setæ forming the feet of a *nereis* or *aphrodita*, and they all point backwards from the naked part of the stem. On watching the polypi of both these zoophytes when fully expanded in pure sea water, their arms and ciliæ were observed remaining like those of the *Lobularia* perfectly motionless, excepting when some floating particles or animalcules impinged against them, which caused them to contract their ciliæ or their tentacula, and sometimes to withdraw themselves languidly into their sheaths or cells. The only motions of the polypi were those of advancing and retreating to their cells, which they did slowly, and with the same irregularity observed in every other zoophyte, no two polypi and no two pinnæ exhibiting any constant uniformity in their motions. The long *ciliæ* of these animals are not vibratory organs, as in many smaller polypi, but are supplementary tentacula which feel, distinguish, and seize their prey when it strikes against them. By looking through the heads of the extended polypi with a lens, I could perceive a constant vibratory motion most obvious in the *Virgulariæ*, within the mouth, apparently produced by minute moving ciliæ placed round the entrance of that passage, and minute particles were occasionally seen propelled from the mouth. The whole fleshy substance of both animals became slowly contracted or distended by agitating or renewing their water, and these motions were as languid as the dilating and contracting of an *actinia*, to which Dr Fleming very justly compares the *Pennatulæ* (*Phil. of Zool.* ii. 613.) The *Virgulariæ* did not exhibit the slightest power of changing their positions, or of retiring from each other when placed in contact with each other perpendicularly in a vessel of sea-water, nor could they turn themselves by distending their pinnæ when they were placed on their faces horizontally at the bottom of the water. The *pennatulæ* showed no power of raising their bodies or swimming in the water, even when pinched and irritated; but in distending their whole fleshy substance, by absorbing water

like an *actinia* or *lobularia*, they exhibited that slow peristaltic or vermicular motion, accurately described by Bohadsch, which passes very gradually over their stem and pinnæ, and causes the pinnæ to assume various positions. The result of this successive distension of the parts when the animal lay horizontally on its back, was an almost imperceptible creeping motion in the direction of the naked part of the stem. This direction was probably given by the bundles of spines placed along the back, and the motion may be quicker when the animal lies on a rough surface, and in its natural element. The motions of the pennatulæ in bending their body, or contracting and extending their pinnæ in different directions, were performed with the same languor as in other fleshy zoophytes, and were not in the least calculated to make them swim to and fro in the sea. Mr Ellis states that they are often found floating near the surface (*Phil. Trans.* liii. 420), but this does not show that they reach that situation by their own efforts, and not by tides, currents, or storms; and there is nothing in Bohadsch's account of the slow motions of the pinnæ which should make Mr Ellis believe that these parts move like the fins of a fish, and serve the same purpose as these organs in making the pennatulæ swim. The fishermen, almost daily accustomed to see these animals, inform me that they have never seen them swimming, but always procure them by their dredges or hook-lines from the bottom, where they shine with so great brilliancy as to enable them to perceive the fishes swimming into their nets. On shaking the *Pennatulæ* in the dark, I observed a few only of the polypi emit a brilliant but momentary bluish white light, and the *Virgulariæ* when shaken, emitted no luminous appearance. From all that I could observe of these animals in the living state, I think it quite improbable that *Pennatulæ* possess the power of swimming to and fro by their own efforts, but that they most likely lie at the bottom, and move in a languid manner, like *Spatangii*, *Asteriæ*, or *Actiniæ*, and that their structure and mode of generation do not differ essentially from those of many other zoophytes.